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Muhammad Shahbaz

COMSATS Institute of Information of Information Technology, Pakistan

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Management Sciences, COMSATS Institute of Information Technology, Lahore, Pakistan

Abstract
The present aims to explore the relationship between financial instability and environmental degradation within multivariate framework using time series data for the period1972-2009 in case of Pakistan. The long run relationship is investigated by ARDL bounds testing approach to cointegration, and error correction method is applied to examine short sun dynamics. The stationarity properties of the variables are tested by applying Saikkonen and Lütkepohl (2002) structural break unit root test. Empirical evidence confirms the existence of long run relationship while financial instability increases environmental pollution in the country.

Keywords: Financial Instability, Environment, Cointegration
JEL Classifications: G2, E44, O16

Introduction

Schumpeter (1911) established a so called relationship between financial sector development and economic growth by exploring the importance of finance as a blood in economic activity. Financial sector plays an intermediary role to mobilize savings from savers to investors and allocates financial resources after monitoring investment projects to potential ventures in an economy. As a result, production level increases that leads to an increase in economic growth rate. Goldsmith, (1969); McKinnon and Shah (1973) and King and Levine, (1993) also argued that financial sector development can be considered as an engine in an economy to stimulate economic growth. A developed and sound financial sector in an economy provides better access to financial services by reducing transactional, information and monitoring cost (Shahbaz, 2009a). This enhances the productivity of allocated resources which in turn results to boost the pace of economic growth. Financial sector also encourages investment activities by issuing loans at cheaper cost and allocates resources to productive ventures, mobilizing savings, enabling trading, offering hedging, diversifying the risks, monitoring the workings of the firms, and directs the firms to use environment friendly technology to enhance the level of output. Further, sound financial sector offers to improve financial decisions, redistributes the financial resources and in turn, economic growth is accelerated (Roubini and Sala-i-Martin, 1992).

Developed and sound financial sector stimulates economic growth and reduces environmental pollutants as well. As Frankel and Romer (1999) pointed out that developed financial markets help to attract foreign direct investment and stimulate the economic growth. Financial development serves as a conduit for modern environment-friendly technology (Birdsall and Wheeler, 1993; Frankel and Rose, 2002). This shows that financial development has direct impact on energy consumption (e.g., Sadorsky, 2010, 2011) and thus on CO2 emissions (Tamazian et al. 2009). A developed financial sector reduces the cost of borrowing and promotes investment (Shahbaz, 2009a and Shahbaz et al. 2010b) and also lowers energy emissions by increasing efficiency in the energy sector (Tamazian et al. 2009 and Tamazian and Rao, 2010). In particular, low borrowing cost enables national, regional and local governments to undertake environment friendly projects. A sound financial sector can promote technological innovation in the energy sector aimed and thus help to reduce pollutant emissions significantly.

In this paper, the question of how financial instability can affect environmental quality or environment degradation has been raised[1]. The natural environment is the most important aspect of an economy which directly takes part in production and indirectly by providing services, it has. Minerals and fossil fuels are considered as environmental resources that are directly used in production function to produce goods and services. This shows the importance of natural resources for economic activity and same inference can be drawn about financial development for economic growth. Financial development may reduce energy pollutants by redirecting the financial resources to environment-friendly business projects[2] as well as developed financial sector can punish the firms by restricting their access to finance if firms release more wastage such as oil spills or chemical explosions (Capelle-Blancard and Laguna, 2010), and capital or credit markets should offer more incentives to firms who are more environmentally responsible[3]. This not only increases

[1] Environment enables the rate of economic growth by sequestering carbon, filtering air and water pollution, protecting against flood risk, and soil formation. It is healthy environment which provides recreational opportunities to improve health while pace of economic growth is much more important for her citizens. It is the rate of economic growth which encourages the adoption of advanced technology and decouples consumption and production depending upon environmental affects. It leads to conclude that both environmental quality and economic growth lead to improve health, education and quality of life which is major concern of an economy.

[2] See for more details, for example, Dasgupta et al. (2001), Gupta and Goldar (2005) and Dasgupta et al. (2006) etc.

[3] Tamazian et al. (2009), Tamazian and Rao (2010), Jalil and Feridun (2010) and latter on Shahbaz et al (2011) empirical proved that financial development is linked with less CO2 emissions.

the market value of firm but also enhances its productivity (Klassen and McLaughlin, 1996). The good (bad) performance regarding environment is linked with an increase (decrease) in the value of stock market shares of said firms.

The main objective of the present paper is to investigate the affect of financial instability on environmental degradation in case of Pakistan. The reason is that sound financial sector monitors projects and issues loans to environment-friendly projects following symmetric information that leads to a decline in CO2 emissions. The relationship between financial development-CO2 emissions is weakened due to an increase in asymmetric informations during the period of financial instability. This asymmetric information may influence the good performance of a firm which put it in difficulty. Further, it is troublesome for firm to pay its loans back to bank, and bank will punish her and firm is far-away to achieve reward mechanism as discussed above. Additionally, mangers of firms are appeared with moral hazard problems to take decision in the adoption of environmental rules to save environment or to adopt environment-friendly technology (Richard, 2010). This further creates financial hardship for the firms when there is possibility of existence of unreliable informations which leads the more incentive to cheat. This implies that during the periods of financial instability, firms are weaker financially due to less availability of funds and firms do less care about environment to enhance their output and hence profits at the cost of environmental degradation.

This paper contributes in environmental economics by three folds: (i) we have created an index of financial instability following Loayza and Rancier (2006) using time series data for the period

1972-2009 in the case of Pakistan[4]. Secondly, ARDL bound testing approach to cointegration is used to examine long run relationship between the series and for short run behaviour, error correction method is applied. Finally, stationarity properties are tested by Saikkonen and Lütkepohl (2002) structural break unit root test. The rest of paper is organized as follows: review of literature is described in section-II. Section-III explains modeling and methodological framework and data collection. The results are discussed in section-IV. Section-V is for conclusion and policy implication.

II. Review of Literature

The relationship between economic growth and environmental degradation is not a novel area of exploration but achieved greater attention of researchers. The association between GDP per capita and CO2 emissions is termed as environmental Kuznets curve (EKC) was established by Kuznets (1955). The hypothesis of relationship between economic growth and energy emissions reveals that economic growth is linked with high energy emissions initially and energy emissions tends to declines as economy achieves turning point or threshold levels of economic growth. The empirical estimation of EKC started by Grossman and Krueger (1991) and latter on by Lucas et al. (1992), Wyckoff and Roop (1994), Suri and Chapman (1998), Heil and Selden (1999), Friedl and Getzner (2003), Stern (2004), Nohman and Antrobus (2005), Dinda and Coondoo (2006), Coondoo and Dinda (2008) and Shahbaz et al. (2010c) etc.

The impact of other macroeconomic variables on CO2 emissions has been investigated by many researchers. For instance, Buitenzorgy and Mol (2011) explored the role of democracy to improve

[4] The value of index ranges from 0-100. Less is value of index means low financial instability (greater access to financial resources) and greater value of index indicates high level of financial instability (less access to finance).

the environmental quality. Their empirical findings indicate an inverted-U relationship between energy pollutants and democracy and democracy reduces energy emissions by improving the authority of governing institutions[5]. Kahuthu (2010) analyzed the association between income per capita and CO2 emissions per capita and reported a support for environmental Kuznets curve in the presence of globalization. This implies direct relation between economic integration with the globe and its effects on environmental quality. Similarly, Choi et al. (2010) investigated the rapport between economic growth and CO2 emissions in framework of environmental Kuznets curve in open economies namely China, Korea and Japan for the period 1971-2006. Their results provided dissimilar picture on the relationship between economic growth and environmental degradation. Their analysis indicated N-shaped and inverted N-shaped relation between economic growth and energy pollutants for China and Japan respectively[6] and economic growth is main factor to decline CO2 emissions. Furthermore, relationship between trade openness and CO2 emissions is U-shaped in China, Korea and Japan. Dutt (2009) investigated income-environment relationship in the perspective of EKC by including other factors such governance, political institutions, socioeconomic conditions and education using cross-country data set for the period 1984–2002. Dutt concluded that countries with better quality of governance, stronger political institutions, better socioeconomic conditions and greater investment in education may affect CO2 emissions to decline. This implies that macroeconomic policies are also responsible for EKC phenomenon[7]. Roberts and

[5] This findings support the view posited by Barrett and Graddy (2000), Farzin and Bond (2006) and Torras and Boyce (1998) argued that citizens are better informed, organized, and able to protest in democratic government. This leads the government officials and political entrepreneurs to per form their duties with more responsibility to save the environment from its degradation.

[6] For Korean economy, results are inconclusive regarding EKC.

[7] Nishitani (2010) utilized an index of economic performance to evaluate the firm's value added using environmental management system. The analysis is based on the use of Japanese manufacturing firms data over the period of 1996-2007 which shows that implementation of environmental management system enhances firm's value added by increasing its product's demand and in resulting, it improves productivity.

Parks (2007) found no effect of democracy on environmental pollutants while Scruggs (1998) reported insignificant impact of democracy on national CO2 emissions.

Energy economics literature also contains some studies investigating the effect of financial development on environment degradation. For instance, Tamazian et al. (2009) examined the impact of economic and financial development on CO2 emissions for BRIC countries including United States and Japan. Their evidence suggested that both factors help to reduce CO2 emissions. More trade liberalization and reforms in financial sector decline CO2 emissions (Tamazian et al. 2009). Tamazian and Rao (2010) applied GMM approach to find out the effect of institutional, economic and financial development on CO2 emissions for the transitional economies. They found the existence of environmental Kuznets curve, and economic, financial and institutional developments are helpful in declining CO2 emissions in transitional economies.

In country case studies, Yuxiang and Chen (2010) used provincial data of Chinese economy to examine the impact of financial development on industrial pollutants and found improvements in environment due to financial development. They claimed that financial development improves environmental quality by increasing income and capitalization, exploiting new technology and implementing regulations regarding environment. Jalil and Feridun (2010) reinvestigated the effects of financial development, economic growth and energy consumption on environmental pollution in China. Their results indicated inverse impact of financial development on CO2 emissions suggesting that financial development in China has not taken place at the expense of environmental pollution. In case of Pakistan, Shahbaz et al. (2011) assessed the effect of financial development on environmental degradation. Their empirical exercise found that financial development reduced CO2 emissions. The main contributors to CO2 emissions however are: economic growth, population and energy consumption. The existence of Environmental Kuznets Curve is also valid in the case of Pakistan. It implies that policy focus on financial development can be a helpful instrument in declining CO2 emissions. In contrast, Bello and Abimbola (2010) found positive effect of financial development (proxied by stock market capitalization) on environmental degradation in case of Nigeria due to the non-monitoring of loans to investment projects by financial sector. Further, EKC does not hold for Nigerian economy and an increase in foreign direct investment is linked with lower CO2 emissions.

In the above studies, researchers focused on financial development and its relation with environment but unable to examine the effect of financial instability on CO2 emissions. However, recently Richard (2010) has hypothesized the relationship between financial instability and CO2 emission[8]. The positive impact of episodes of financial instability is found on environmental degradation in advanced and emerging economies by using static and dynamic models. The results indicated the validation of EKC and population density is main contributor to increase CO2 emissions in these economies. On contrary, Brussels (2010) reported that financial crisis does not harm environment. Further, Brussels concluded that financial crisis reduced CO2 emissions by 24% in Estonia, 22% in Romania, 16% in Italy and Spain and 13% in UK. Similarly, Declercq et al. (2011) investigated the effect of economic depression on energy pollutants for European power sectors over the years 2008-2009 using simulation models. They identified that electricity consumption, the CO2 price and fuel prices are main determinants of energy emissions by EU power generating sector. The less electricity demand reduces energy pollutants by 175 metric tons

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[8] Austria, Belgium, Canada, Denmark, Finland, France, Germany, Italy, Japan, Netherlands, Norway, Spain, Sweden, Switzerland, Great Britain, USA, Argentina, Brazil, Chile, China, Colombia, Hungary, Korea, Morocco, Mexico, Malaysia, Peru, Philippine, Poland, Russia, South Africa, Thailand and Turkey

while decline in prices of CO2 is linked with 30 metric tons reduction in CO2 emissions and combined effect of electricity and CO2 prices on the decline of CO2 emission is 150 metric tons during recession period for the European power sector. But Enkvist et al. (2010) reported that global financial crisis has little effect on energy pollutants. The above discussion showed no particular which investigated the relationship between financial instability and CO2 emissions in case of Pakistan. This study is an effort to fill this gap in literature and is the main motivation for researchers.

III. Modeling and Data Collection

This study aims to investigate the effect of financial instability on environmental degradation using time series data over the period 1972-2009 in an open economy like Pakistan. We exercise economic growth, financial instability, energy consumption, trade openness and CO2 emissions in single multivariate framework following Talukdar and Meisner (2001), Tamazian et al. (2009) and Tamazian and Rao (2010). Following Selden and Song (1994), Grossman and Krueger (1995), Friedl and Getzner (2003) and Shahbaz et al. (2010c), we use log-linear specification to examine the impact of financial instability on CO2 emission. The log-linear specification is superior to simple linear specification because log-linear provides efficient and consistent empirical findings as compared to latter one. The above discussion leads to formulate the empirical equation as following:

$$CO2_t = f(FNS_t, Y_t, ENC_t, TR_t) \tag{1}$$

$$\ln CO2_t = \alpha_1 + \alpha_2 \ln FNS_t + \alpha_3 \ln Y_t + \alpha_4 \ln ENC_t + \alpha_5 \ln TR_t + \mu_t \tag{2}$$

Where, $CO2_t$ is CO2 emissions per capita, FNS_t is for financial instability, an index generated by author, $Y_t\,(Y_t^2)$ is real GDP per capita (square term of real GDP per capita), ENC_t is for energy demand proxies by energy consumption per capita and TR_t is trade openness [(exports + imports)/GDP]. The study covers the data period 1972-2009.

In the presence of financial instability, we test the existence of environmental Kuznets curve following Baek and Koop (2008), Tamazian et al. (2009) and Tamazian and Rao (2010), Jalil and Feridun (2010) in an open economy. The empirical equation is modeled as follows:

$$\ln CO2_t = \beta_1 + \beta_2 \ln FNS_t + \beta_3 \ln Y_t + \beta_4 \ln Y_t^2 + \beta_5 \ln ENC_t + \beta_6 \ln TR_t + \mu_t \qquad (3)$$

The data on CO2 emissions per capita, real GDP per capita, energy consumption per capita, trade as share of GDP has collected from World Development Indicators (CD-ROM, 2010). The index for financial instability is generated by the author following Loayza and Ranciere (2006). Two approaches are reported to measure financial instability; first is the standard deviation growth rate of concerned variable and second is the absolute value of residuals that has been acquired by regressing the variable (FD) on its lagged value with time trend[9]. In simple words, let V_{FD} is a measure of the variable FD instability, and let g^{FD} shows the growth rate of financial development (FD):

The standard deviation of FD is: $$V_1^{FD} = \sqrt{\sum_{t=1}^{n} \frac{1}{n-1} \left(g_t^{FD} - FD^{FD} \right)^2}$$

[9]The residuals and the standard deviation yield results similar to the absolute value of residuals.

The average of the absolute value of residuals is: $V_2^{FD} = \frac{1}{n}\sum_{t=1}^{n}|\varepsilon_t|$

ε is obtained by estimating the following equation:

$$x_t = \alpha + \beta_1 x_{t-1} + \beta_2 t + \mu_t$$

It can be modified according to interest of our study as following: $FD_t = \beta_1 + \beta_2 FD_{t-1} + \beta_3 t + \mu_t$.

The second method to measure financial instability is more superior to later one. The first approach does not assume a stochastic or deterministic time trend while latter assumes that.

IV. Estimation Techniques

Saikkonen and Lütkepohl Structural Break Unit Root Test

The order of integration of the variables has been extensively investigated through ADF, P-P, DF-GLS, Ng-Perron etc unit root tests. These tests may provide inefficient and biased results when shift prevails in time series data. In such case, shift in time series should be accounted in testing unit root problem. So, we have used model proposed by Saikkonen and Lutkepohl (2002) and Lanne et al. (2002) to carry out unit root analysis. The empirical equation is modeled as follows:

$$y = \mu_0 + \mu_1 t + f_t(\theta)' \gamma + \varepsilon_t \qquad (4)$$

Where $f_t(\theta)'\gamma$ indicates the shift function to be used while θ and γ are considered as unidentified vectors. ε_t is generated by an $AR(p)$ process. A simple shift dummy variable with shift date T_B is used on the basis of exponential distribution function. This function i.e. $f_t^{'} = d_{1t} : \begin{cases} 0, t < T_B \\ 1, \geq T_B \end{cases}$ does not

to entail any parameter θ in the shift term $f_t(\theta)^{'}\gamma$ where γ is scalar parameter. We follow Lanne et al. (2002) to choose dates of structural breaks exogenously in time series which allows us to apply ADF-type test on the series to check stationarity properties. Saikkonen and Lutkepohl (2002) and Lanne et al. (2002) also suggested to use large autoregressive in finding break date. This seems to help in minimizing generalized least square error of objective function to be applied for the investigation of deterministic parameters.

ARDL Bounds Testing Approach to Co integration

This paper applies the ARDL bounds testing approach to cointegration advanced by Pesaran et al. (2001) to examine the long run relationship between financial instability, income, energy consumption, trade openness and CO2 emissions in case of Pakistan. There are certain advantages of this approach. First, the long run and short run estimates can be estimated simultaneously. Secondly, ARDL bounds testing approach can be applicable to examine long run relationship if variables have mixed of integration i.e. I(0) or I(1) or I(0)/I(1). Thirdly, it has better properties for small sample data sets. The unrestricted error correction model (UECM) is followed and equation for estimations are given below:

$$\begin{aligned} \Delta \ln CO2_t = {} & \varphi_0 + \varsigma_y T + \pi_1 \ln FNS_{t-1} + \pi_2 \ln Y_{t-1} + \pi_3 \ln ENC_{t-1} + \pi_4 \ln TR_{t-1} + \sum_{i=1}^{p} \lambda_y \Delta \ln CO2_{t-i} \\ & + \sum_{j=0}^{p} \gamma_y \Delta \ln FNS_{t-j} + \sum_{i=0}^{p} \alpha_y \Delta \ln Y_{t-i} + \sum_{i=0}^{p} \beta_y \Delta \ln ENC_{t-i} + \sum_{i=0}^{p} \rho_y \Delta \ln TR_{t-i} + \varepsilon_t \end{aligned} \quad (5)$$

Where, Δ is the first difference operator; constant term is denoted by φ_0; long run coefficients are indicated by π_s while $\lambda, \gamma, \alpha, \beta, \rho$ are short-run parameters, ε_t is the residual term which is assumed to be normally distributed and T stands for time trend. Akaike Information Criteria (AIC) is used to select the optimal lag length.

The asymptotic distributions of the test statistics are non-standard regardless of whether the variables are I(0) or I(1). Lower and upper critical bounds are available to take the decision about the existence of cointegration between the variables. The joint null hypothesis of no cointegration is $H_0 : \pi_1 = \pi_2 = \pi_3 = \pi_4 = 0$ against alternative hypothesis of cointegration i.e. $H_a : \pi_1 \neq \pi_2 \neq \pi_3 \neq \pi_4 \neq 0$ referred to as estimated function such as $F_{CO2}(CO2 / FNS, Y, ENC, TR)$ for equation-5. Pesaran et al. (2001) have followed the assumption of I(0) or I(1) to tabulate the lower critical bound (LCB) and upper critical bound (UCB). If computed F-statistic is more than upper critical bound then null hypothesis may be rejected. It implies the cointegration between the variables. Hypothesis of no cointegration can be followed if computed F-statistic is less than lower critical bound. Moreover, the results will be inconclusive if calculated F-statistic is between lower critical and upper critical bounds[10]. We have used critical bounds generated Narayan (2005) which are more suitable for small sample data sets as compared to Pesaran et al. (2001). When there is long run relationship among variables, there exists an error correction representation which is estimated, using the following reduced form of equation to examine short run behaviour of the variables:

$$\ln CO2 = \varphi_1 + \sum_{i=0}^{p} \varphi_1 \Delta \ln FNS_{t-i} + \sum_{j=0}^{q} \varphi_2 \Delta \ln Y_{t-j} + \sum_{k=0}^{r} \varphi_3 \Delta \ln ENC_{t-k} + \sum_{l=0}^{t} \varphi_4 \Delta \ln TR_{t-l} + \eta ECM_{t-1} + \mu_t \quad (6)$$

[10] In such case, error correction method is appropriate and reliable approach to investigate the cointegration (Bannerjee et al. 1998). This indicates that error correction term will be a useful way of establishing cointegration.

Where, Δ is difference operator and ECM is error-correction term which implies that change in the response variable is a function of disequilibrium in the cointegrating relationship and the changes in other explanatory variables. To examine the stability of the ARDL bounds testing approach to cointegration, stability tests namely CUSUM and CUSUMSQ have been applied.

V. Results Interpretation

Table-1indictaes that all series are normally distributed as shown by statistics of Jarque-Bera test. Pair-wise correlation analysis reveals that financial instability, income, energy consumption and trade openness are positively associated with CO_2 emission in case of Pakistan. There is positive correlation of energy consumption and trade with economic growth and between trade and energy consumption. We have begun with Ng-Perron (2001) unit root test to examine order of integration of the variables. The results indicated that financial instability and trade openness are integrated at I(0) while CO_2 emissions, income and energy consumption have unit root problem at their level form but are stationary at 1st differenced form[11]. Ng-Perron unit root test does not seem to have information about structural breaks in time series data. In doing so, stationarity properties of the variables of interest in the presence of structural break have been tested by applying Saikkonen and Lütkepohl (2002). The results of Saikkonen and Lütkepohl (2002) unit root test are reported in Table-2.

[11] The results are not reported but available form author upon request.

Table-1: Descriptive Statistics and Correlation Matrix

Variables	$\ln CO2_t$	$\ln FNS_t$	$\ln Y_t$	$\ln ENC_t$	$\ln TR_t$
Mean	11.0713	-0.3376	10.0561	5.9781	3.5307
Median	11.1607	-0.3025	10.1337	6.0206	3.5476
Maximum	12.0035	2.9214	10.5047	6.2724	3.6612
Minimum	9.9674	-3.9069	9.5883	5.6566	3.3221
Std. Dev.	0.6229	2.0021	0.2646	0.1976	0.0936
Skewness	-0.3098	-0.1994	-0.3338	-0.3166	-0.6104
Kurtosis	1.8668	2.0371	2.0698	1.7233	2.6308
Jarque-Bera	2.5019	1.6292	1.9665	3.0464	2.4403
Probability	0.2862	0.4428	0.3740	0.2180	0.2951
$\ln CO2_t$	1.0000				
$\ln FNS_t$	0.0215	1.0000			
$\ln Y_t$	0.4127	-0.2318	1.0000		
$\ln ENC_t$	0.5549	-0.1575	0.4332	1.0000	
$\ln TR_t$	0.0874	-0.3761	0.1843	0.1304	1.0000

Table 2: SL Unit root analysis

Unit Root Test with structural break: Constant and Time trend included					
Variables	Shift dummy and used break date is 2004	Saikkonen and Lütkepohl (k)	Variables	Shift dummy and used break date is 2000	Saikkonen and Lütkepohl (k)
$\ln CO2_t$	Yes	-4.0455***(1)	$\ln FNS_t$	Yes	-1.8538(0)
$\Delta \ln CO2_t$	Yes	-2.2108 (1)	$\Delta \ln FNS_t$	Yes	-3.5641***(0)
	Shift dummy and used break date is 1987	Saikkonen and Lütkepohl (k)	Variables	Shift dummy and used break date is 1979	Saikkonen and Lütkepohl (k)
$\ln EC_t$	Yes	-1.4379 (0)	$\ln TR_t$	Yes	-2.1033 (0)
$\Delta \ln EC_t$	Yes	-2.2871 (0)	$\Delta \ln TR_t$	Yes	-4.8168*** (0)
	Shift dummy and used break date is 1980			Saikkonen and Lütkepohl (k)	
$\ln Y_t$	Yes			0.2865 (0)	
$\Delta \ln Y_t$	Yes			-3.1631***(0)	

Note: (1) ***, ** and * denotes significance at 1%, 5% and 10% level respectively. k denotes lag length. Critical values are -3.55, -3.03, and -2.76 which are based on Lanne et al. (2002) at 1%, 5%, and 10% respectively.

In this analysis we used sift dummy for structural beaks for all variables. The empirical evidence showed that $\ln CO2_t$ is stationary in the presence of structural break occurred in 2004 (the date of structural break was determined endogenously) and found stationary in level form and same inference can be drawn about $\ln TR_t$ variable but at 10 % level of significance.

Other variables such as $\ln FNS_t$, $\ln EC_t$ and $\ln Y_t$ are non-stationary in level form in the presence of structural breaks. In case of first differenced form, these three variables become stationary in the presence of structural breaks (determined in level form of the variables and after making these variables in first difference form and then identifying the break date and incorporating that break date in the unit root analysis)[12]. The results imply that variables have mixed order of integration I(0) for $\ln CO2_t$ and $\ln TR_t$, I(1) for $\ln FNS_t$, $\ln EC_t$ and $\ln Y_t$. This lends a support to apply ARDL bounds testing approach to cointegration to examine long run relationship between $\ln CO2_t$, $\ln FNS_t$, $\ln EC_t$, $\ln Y_t$ and $\ln TR_t$ for the period 1972-2009. It is pointed out by Ouattara (2004) that in the presence of $I(2)$ series the computed F-statistic may not make sense. Since, Pesaran et al. (2001) critical values are based on the assumption that the variables are stationary of order $I(0)$ or $I(1)$. The confirmation of order of integration tends to apply ARDL bounds testing approach to cointegration after the appropriate lag length selection of each variable. In doing so, we apply the UECM-ARDL model to select the appropriate lag length[13] by using the Akaike's Information Criterion (AIC). The results are pasted in Table-3 showing lag 2 is optimal lag order.

[12] However, we are not reporting results of second part of the analysis i.e., endogenous determination of structural break in first difference form
[13] For more details see Shahbaz (2009a)

Table-3 Lag Length Criteria

VAR Lag Order Selection Criteria

Lag	LogL	LR	FPE	AIC	SC	HQ
0	114.4877	NA	7.34e-10	-6.8429	-6.6139	-6.76706
1	245.2752	212.5296	1.01e-12	-13.4547	-12.0805*	-12.9992
2	276.8723	41.4713*	7.56e-13*	-13.8670*	-11.3477	-13.0319*
3	291.5680	14.6956	2.04e-12	-13.2230	-9.5586	-12.0083

* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

We use critical bounds tabulated by Narayan (2005), the critical values provided by Pesaran et al. (2001) are inappropriate for a small sample. The sample size of our study is relatively small i.e. T = 38. The results of ARDL bounds testing approach to cointegration are reported in Table-4 indicate that calculated F-statistic is higher than upper critical bound at 1 per cent level of significance when financial instability, economic growth, energy consumption and trade openness have been assigned as forcing variables. This shows the existence of cointegration which confirms the long run relationship between financial instability, economic growth, energy consumption, trade openness and energy emissions in case of Pakistan. Diagnostic checks have also been conducted to examine the stability of ARDL model. The results reveal that selected UECM-ARDL model is free from specification error indicated by Ramsey RESET test. The error term is normally distributed and standard statistical inferences (i.e., t-statistic, F-statistic, and R-squares) are valid. Similarly, there is no problem of serial correlation, autoregressive conditional heteroscedisticity and same inference can be drawn for white heteroscedisticity.

Table-4: The Results of ARDL Cointegration Test

Panel I: Bounds testing to cointegration		
Estimated Equation	$\ln CO2_t = f(\ln FNS_t, \ln Y_t, \ln EC_t, \ln TR_t)$	
Optimal lag structure	(2, 1, 1,2 , 0)	
F-statistics (Wald-Statistics)	8.928*	
Significant level	Critical values (T = 38)#	
	Lower bounds, $I(0)$	Upper bounds, $I(1)$
1 per cent	6.328	7.408
5 per cent	4.433	5.245
10 per cent	3.698	4.420
Panel II: Diagnostic tests	Statistics	
R^2	0.8508	
Adjusted- R^2	0.6817	
F-statistics (Prob-value)	5.0322(0.0014)*	
Durbin-Watson	1.9659	
J-B Normality test	0.3116 (0.8557)	
Breusch-Godfrey LM test	1.2368 (0.2848)	
ARCH LM test	1.2147 (0.2792)	
White Heteroskedasticity Test	0.3167 (0.9874)	
Ramsey RESET	0.8039 (0.4686)	

Note: The asterisk * denote the significant at 1% level of significance. The optimal lag structure is determined by AIC. The probability values are given in parenthesis. # Critical values bounds computed by (Narayan, 2005) following unrestricted intercept and restricted trend.

The long run results show that financial instability has positive impact on CO2 emissions and it is statistically significant at 10 per cent level of significance. It is noted that a 0.0741 per cant increase in CO2 emissions is linked with a 1 per cant increase in financial instability. These findings are consistent with view explored by Richard (2010). Real income affects energy emissions positively and significantly. The results indicate that income has dominated effect on energy pollutants after energy consumption. It is documented on the basis of our findings that a 1 per cent boost in real income per capita will lead 0.9961 per cent increase in CO2 emissions, other things being equal. This result is confirmation of established relation by Shahbaz et al. (2010c) in case of Pakistan.

Table-5: Long Run Relationship

Dependent Variable = $\ln CO2_t$				
Variable	Coefficient	T-Statistics	Coefficient	Prob-Value
Constant	-9.3177	-24.3804**	-4.8377	-6.8035**
$\ln FNS_t$	0.0741	6.1469*	0.0404	1.8134***
$\ln Y_t$	0.9961	0.0001	7.9093	5.7405*
$\ln Y_t^2$	….	….	-0.3855	-5.5445*
$\ln EC_t$	1.8639	8.9023*	1.6267	10.4510*
$\ln TR_t$	-0.2170	-2.6124**	….	….
$\ln URB_t$	….	….	0.2682	7.3987*
Diagnostic tests		Statistics		Statistics
R-squared		0.9963		0.9989
Adjusted R-squared		0.9958		0.9987
F-statistic		2037.580**		5267.946*
J-B Normality test		1.8803 (0.1567)		0.9984 (0.6070)
Breusch-Godfrey LM test		0.4963 (0.7802)		0.4902 (0.6178)
ARCH test		0.8145 (0.3735)		0.2823 (0.5988)
Heteroscedisticity Test		0.4126 (0.7981)		0.3336 (0.8884)
Ramsey RESET		0.0851 (0.7726)		1.9326 (0.1754)

The empirical analysis shows that impact of energy consumption on energy pollutants is positive and dominated significantly. It is noted that a 1 per cent increase in energy consumption is linked with 1.86 per cent increase in energy emissions, other things being equal. Energy consumption by domestic and transport factors raises energy emissions almost by 50% of total energy and same inference can be drawn from economic factors (GOP, 2010). It corroborates the findings by Shahbaz et al. (2010c). The estimates of both studies are different due to data spans and models, are used. These results support the view by Hamilton and Turton (2002) for OECD countries, Friedl and Getzner (2003) for Austria, Ang (2007) for France, Ang (2008) for Malaysia, Say and Yücel (2006) and Halicioglu (2009) for Turkey, Liu (2005) and Jalil and Mehmud (2009) for China.

An increase in trade openness is inversely linked with environmental degradation. It implies that trade openness declines CO2 emissions through technique effect keeping scale and composition effects constant. This provides support to view that a change in policy is induced due to change in income level that may lead to change in production techniques to save environmental degradation per unit of output. It further shows that new techniques adopted by Pakistan produce less CO_2 emissions during production process as compared to old ones. This finding is steady with the empirical evidence provided by Shahbaz et al. (2010c). It is noted that a 1 per cent increase in trade openness declines energy pollutants by 0.2170 per cent with significance.

The non-linear relationship between income and CO2 emissions is investigated and results are reported in 4th column of Table-5. Our empirical evidence confirms the existence of inverted U-shaped relation between economic growth and energy pollutants by significance of both linear and non-linear terms of real GDP. The results show that a 7.90 per cent increase in CO2 emissions will be raised with 1 per cent rise in real GDP per capita while coefficient of non-linear term of real GDP per capita is negative i.e. -0.3855, confirms to delinking of energy pollutants and real GDP per capita at high level of income. The long run results of CO2 emissions with real GDP per capita is 7.9093-0.3855 and threshold point in Pakistan is equalant to PRS 28449 or $ 550. This empirical evidence corroborates that initial level of economic growth is linked with high CO2 emissions and CO2 emissions starts to decline at high level of economic growth after threshold point in case of Pakistan. This evidence is consistent with the line of existing literature such as Shahbaz et al. (2010c) and Nasir and Faiz (2010) for Pakistan, Fodha and Zaghdoud (2010) for Tunisia, Chang (2010) for China, Lean and Smyth (2010) for ASEAN countries and Iwata et al. (2010) for France, etc.

The association between urbanisation and CO2 emissions is positive and it is statistically significant. It may be documented on the basis of our empirical evidence that 1 per cent increase in urbanisation is linked with 0.2682 per cent CO2 emissions. The urban population was 25.1% of total population, 81 persons/km population density and CO2 emissions 1.2865 metric tons with energy consumption 278.55 (kg of oil equivalent) per capita in 1971. In 2009, urban population has risen to 36.4% of total population and population density to 220 persons/km which increased CO2 emissions to 2.099 metric tons, almost CO2 emissions growth rate is 63.15% (GOP, 2010). Moreover, rising industrial or manufacturing activities in cities also produce substantial portion of energy pollutants such as water and air pollution. This provides the support to empirical evidence by Alam et al. (2007) for Pakistan.

Table-6: Granger Causality Analysis

Direction of Causality	F-Statistics
$\ln FNS_t \Rightarrow \ln CO2_t$	2.1471***
$\ln FNS_t \Leftarrow \ln CO2_t$	0.6031
$\ln Y_t \Rightarrow \ln CO2_t$	2.1208***
$\ln Y_t \Leftarrow \ln CO2_t$	1.65484
$\ln Y_t^2 \Rightarrow \ln CO2_t$	2.0880***
$\ln Y_t^2 \Leftarrow \ln CO2_t$	1.7789

Note: *** shows significant at 10% level of significance.

The results of granger causality analysis are reported in Table-6. The analysis reveals that there is unidirectional causality running from financial instability to environmental degradation i.e. $\ln FNS_t \Rightarrow \ln CO2_t$ and it is significant at 10% level of significance. It implies that during financial crisis, firms do not care much about environment for production and raise their output to increase their profits at the cost of environment. Furthermore, that $\ln Y_t$ ($\ln Y_t^2$) Granger causes $\ln CO2_t$

emissions at 10% level of significance. The causality result also validates the existence of environment Kuznets curve (EKC) in long run as reported in Table-5 in column-4.

Table-7: Short Run Results

Dependent Variable = $\Delta \ln CO2_t$			
Variable	Coefficient	T-Statistic	Prob-value
Constant	0.0148	2.4808**	0.0194
$\Delta \ln FNS_t$	0.0420	2.2306**	0.0339
$\Delta \ln Y_t$	0.8476	3.1600*	0.0038
$\Delta \ln EC_t$	1.1768	3.8100*	0.0007
$\Delta \ln TR_t$	-0.0103	-0.1754	0.8620
ECM_{t-1}	-0.4160	-4.1972*	0.0002
Diagnostic Test			
R-squared		0.5260	
Adjusted R-squared		0.4414	
F-statistics		6.2154*	
Durbin-Watson		2.4377	
J-B Normality Test		0.5275 (0.7681)	
Breusch-Godfrey LM Test		1.6198 (0.2099)	
ARCH LM Test		0.2838 (0.5980)	
White Heteroskedasticity Test		0.4806 (0.9318)	
Ramsey RESET		1.0728 (0.3095)	

Note: *(**) indicates significance at 1% (5%) and Prob-values are shown in parentheses.

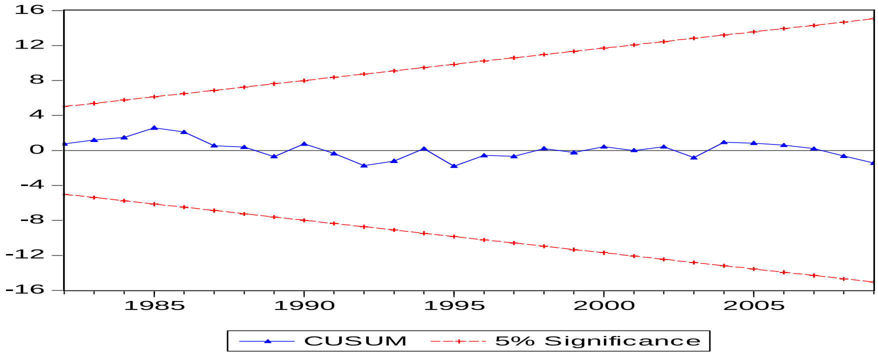
The huge debate over long run results leads us to discuss short run results. The short run empirical results are pasted in Table-7 using error correction method following ARDL model. The results reveal positive effect of financial instability on environmental degradation and it is statistically significant at 5% level of significance. A rise in per capita income is positively associated with CO2 emissions and like long run, economic growth is also dominating factor in short run after energy consumption to increase environmental degradation. The substantial portion of CO2 emissions is contributed by energy consumption. It is noted that a 1 per cent increase in energy use will raise CO2 emissions by 1.1768 per cent in the country. The impact of trade openness is negative but it is statically insignificant. In Table-7, we can perceive that the coefficient of lagged error term i.e.

ECM_{t-1} is between 0 and -1 showing significance at 1 per cent level. It entails that significance of error term shows the speed of adjustment towards long run from short span of time and confirms our ascertained long run relation. The sign of estimated coefficient of ECM_{t-1} is -0.4160. This indicates that change from the equilibrium level of CO2 emissions is corrected by 41.60 per cent per year in the country.

The stability tests such as cumulative sum of recursive residuals (CUSUM) and the CUSUM of square ($CUSUM_{SQ}$) developed by Brown et al. (1975) have been conducted. It is pointed out by Hansen (1992) that estimated coefficients may be different in time series data due to misspecification of model. These unstable estimates may produce prospective biasedness in results that affect the explaining power of the results. The CUSUM and CUSUMsq tests are applied to observe the constancy of the parameters[14]. The null hypothesis of these tests is that the regressions coefficients are constant overtime and vice versa.

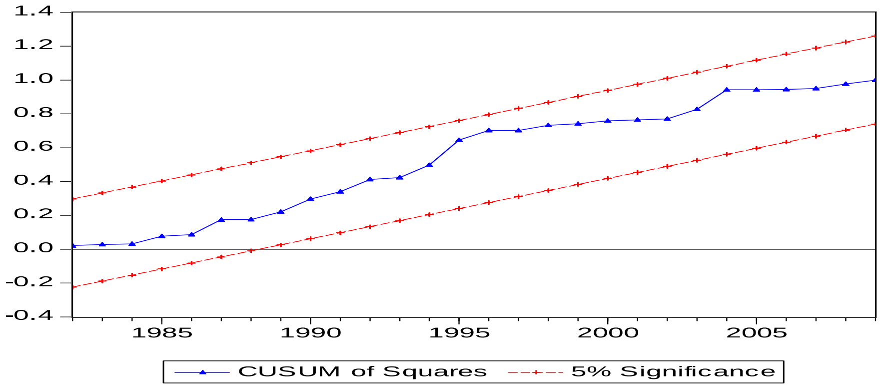
[14] The first of these involves a plot of the cumulative sum (CUSUM) of recursive residuals against the order variable and checking for deviations from the expected value of zero. Symmetric confidence lines above and below the zero value allow definition of a confidence band beyond which the CUSUM plot should not pass for a selected significance level. A related test involves plotting the cumulative sum of squared (CUSUMSQ) recursive residuals against the ordering variable. The CUSUMSQs have expected values ranging in a linear fashion from zero at the first-ordered observation to one at the end of the sampling interval if the null hypothesis is correct. Again, symmetric confidence lines above and below the expected value line define a confidence band beyond which the CUSUMSQ plot should not pass for a selected significance level, if the null hypothesis of parameter constancy is true. In both the CUSUM and CUSUMSQ tests, the points at which the plots cross the confidence lines give some in diction of value(s) of the ordering variable associated with parameter change.

Figure-1 Plot of Cumulative Sum of Recursive Residuals



The straight lines represent critical bounds at 5% significance level

Figure-2 Plot of Cumulative Sum of Squares of Recursive Residuals



The straight lines represent critical bounds at 5% significance level

Brown et al. (1975) pointed out that these residuals are not very sensitive to small or gradual parameter changes but it is possible to detect such changes by analyzing recursive residuals. They argue that if the null hypothesis of parameter constancy is correct, then the recursive residuals have an expected value of zero, and if the parameters are not constant, then recursive residuals have non-zero expected values following the parameter change. The plots of both CUSUM and CUSUMsq are shown by Figure-1 and 2 at 5 per cent level of significance. Results indicate that plots of both tests are with critical boundaries at 5 per cent level of significance implying the constancy of parameters in both cases. The analysis of diagnostic tests shows that short run model has passed all tests successfully. It is evidenced that normality of residual term is confirmed by Jarque-Bera estimates, and variables are not serially correlated in short span of time. There is no evidence of autoregressive conditional heteroskedasticity, and same inference can be drawn for white heteroskedasticity. The functional form of short run model is well specified as confirmed by estimates of Ramsey Reset test. The stability and sensitivity analysis shows that ARDL and short run results are stable and reliable for policy purpose regarding CO2 emissions in the country.

VI. Conclusion and Policy Implication

Stable and sound financial system stimulates economic growth through investment-enhancing effect. Developed financial sector plays a vital role in reduction of energy pollutants or CO2 emissions by providing an incentive to firms to adopt environment friendly techniques during production process. Financial development attracts foreign direct investment from developed world to emerging economies and in host country, foreigners use advanced technology that not only enhances domestic production but also improve environmental quality in host country (Frankel and Romer, 1999). Moreover, financial sector motivates the local firms to adopt environment-friendly techniques for production process. It implies that sound financial sector may improve environment quality through new technology using-effect but this effect is nullified during periods of financial instability.

The present study investigated the association between financial instability and environmental degradation. ARDL bounds testing approach used for long run relationship and short run dynamics have been estimated by applying error correct method. The results confirmed long run relationship between financial instability, economic growth, energy consumption, trade openness and financial instability. The effect of financial instability is positive on CO_2 emissions. It implies that a rise in financial instability is harmful for environment in Pakistan. Environmental Kuznets curve (EKC) exists and dominant role is played by energy consumption to CO_2 emissions. Finally, trade openness is inversely linked with CO_2 emissions.

In the context of policy implications, to avoid financial instability and its impact on environmental degradation, financial sector reforms should be implemented step by step with great care. Financial institutions should be permitted to work without any political influence. Waiving and issuance of loans on political grounds should be discouraged. This is not only wastage of national resources but also more resources are needed to save environment due to negative externality of financial instability on environment. If any firm is financially defaulter then financial sector should take care of that firm for the sake of environment by giving her relaxation in paying the loan back.

The present study opens up new dimensions for future research such as current model of our study can be improved by including other variables i.e. governance, institutional quality, political stability or democracy and economic instability etc to examine more appropriate determinant of CO_2 emissions. This idea can be enhanced to investigate the effect of current US financial crisis on environmental degradation in developed and developing economies of the globe. The availability of data on domestic credit to private sector at provincial level will make possible to conduct a study to examine the effect of financial instability on environment at state level which might provide new ways to policy makers to sound financial markets and hence environment.

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